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Fiscal multipliers and prospects for consolidation

by
Ray Barrell, Dawn Holland *and* Ian Hurst*

This article looks at various aspects of fiscal consolidation in 18 OECD economies. The prospects for fiscal consolidation depend upon the problems a country may face with its debt stock, the political will to deal with these problems and on the costs of consolidation. These costs are a function of the impacts of fiscal policy on the economy, which is the focus of this study. The analysis is based on a series of simulations using the National Institute Global Econometric Model, NiGEM. Fiscal multipliers differ across countries because the structure and behaviour of economies differ. They also differ within countries, depending on factors such as the fiscal instrument implemented, the policy response to fiscal innovations, and expectation formation by economic agents. The purpose of this study is to allow an assessment of the likely impact on the economy and on the fiscal position of consolidation programmes. We decompose the key factors that determine the size of the multiplier by changing them one at a time. Even under a specified set of assumptions, the outturn for the budget balance retains a high degree of uncertainty. We illustrate this uncertainty by calibrating probability bounds around projected debt profiles. This can allow an assessment of the probability of achieving specified fiscal targets, such as those set out in the European Union's new Fiscal Compact.

JEL classification codes: E17; E37; E62

Key words: Large scale structural macro models; fiscal multipliers; rational expectations; budget consolidation in the OECD

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The severe recessions as a result of the financial crisis in 2008-09 resulted in a sharp rise in government budget deficits in almost all major industrialised countries. The cyclical impact was compounded by fiscal stimulus packages and emergency financial sector support. This in turn has led to a sharp rise in global government debt, giving rise to concerns about long-term fiscal sustainability. Pressures have been particularly high in some euro area countries, which have pushed government bond yields to exceptionally high levels in some countries such as Spain, Italy, Portugal and Greece. As a result, fiscal consolidation packages have been introduced by many of the major economies to stem the rise in sovereign debt.

This paper considers the impacts of fiscal consolidation on GDP growth in 18 OECD economies. The analysis is based on a series of simulations using the National Institute Global Econometric Model, NiGEM.[1] The key features of the model are that it is estimated and has a common structure across the 18 countries. If the results differ across countries it will be because they are different. Some of these differences, such as the openness of the economy, are important. They change over time and they are not related to estimation. Others, such as the speed of response to changes in income, do depend upon how the model was estimated. Details underlying key equations and the core structure of NiGEM are given in the Appendix.

Fiscal multipliers differ across countries because the structure and behaviour of economies differ. They also differ within countries, depending on factors such as the fiscal instrument implemented, the policy response to fiscal innovations, and expectation formation by economic agents. Much of the recent literature on fiscal multipliers also suggests that the size of the multiplier may also depend on the state of the economy (see, for example, Delong and Summers, 2012; Auerbach and Gorodnichenko, 2012). Others have focused on identifying links between the fiscal position and the risk premium on government borrowing, which is of particular importance in the euro area (see *e.g.* Arghyrou and Kontonikas, 2011; Bernoth *et al.*, 2012; De Grauwe and Ji, 2012; Schuknect *et al.*, 2010, Corsetti *et al.*, 2012).

The purpose of this study is to allow an assessment of the likely impact on the economy and on the fiscal position of the consolidation programmes that are being introduced. The impact will depend on the factors discussed above – structure and behaviour of the economy, fiscal instruments, expectation formation, policy response, state of the economy – and we decompose these factors by changing them one at a time. Even under a specified set of assumptions, the outturn for the budget balance retains a high degree of uncertainty. We illustrate this uncertainty in selected countries by calibrating probability bounds around the projected debt profiles. This can allow an assessment of the probability of achieving specified fiscal targets, such as those set out in the European Union's new Fiscal Compact.

1. Short-term impact multipliers

Barrell, Fic and Liadze (2009) demonstrate that multipliers are time and state dependent. Fiscal multipliers differ across countries because the structure and behaviour of economies

differ. They also differ within countries, depending on factors such as the fiscal instrument implemented, the policy response to fiscal innovations, and expectation formation by economic agents. Thus there is no single "multiplier" that can be attributed to a given economy, as the impact of a fiscal innovation on GDP depends on a wide range of factors. In this section we decompose the impact of several of these factors by changing them one at a time.

1.1. Fiscal instruments

In a model such as NiGEM multipliers are small. They average around 0.3 or less, as can be seen from Tables 1 and 4 below. Even then these estimates probably exceed the multipliers that one would see with any actual consolidation programme, because for some actions implementation speed is faster in the model than in the world. If one allows for more gradual implementation, this would reduce average multipliers to below 0.2. This matters in particular when comparing multipliers for taxes and benefits to those for spending. Taxes or benefits can be cut by 1% of GDP relatively easily both in the model and in the world. Multipliers in response to income tax and benefit adjustments are small, as a part of the decline in personal sector income is offset by a temporary adjustment in the savings rate. As one can see from the tables, multipliers appear larger for cuts in real government spending. This is in part because of the assumption that such cuts can be implemented immediately, and this is certainly not the case. It is also in part because government consumption is part of the income identity and hence when it is cut (and the number of people employed or goods and services bought is reduced) measured real output falls. If one were to reduce government spending by as much, but do it through wage reductions, then the impact on real GDP would be much less, and the second round effects of the shock would effectively be the same as an increase in taxes.

Table 1. **First-year multipliers from 1% of GDP temporary fiscal contraction**

	Government spending		Taxes	
	Consumption	Benefits	Indirect	Direct
Australia	–0.82	–0.27	–0.25	–0.22
Austria	–0.53	–0.17	–0.09	–0.13
Belgium	–0.17	–0.04	–0.05	–0.03
Canada	–0.53	–0.16	–0.05	–0.12
Denmark	–0.53	–0.10	–0.06	–0.04
Finland	–0.64	–0.14	–0.09	–0.08
France	–0.65	–0.32	–0.09	–0.27
Germany	–0.48	–0.29	–0.09	–0.27
Greece	–1.07	–0.44	–0.22	–0.32
Ireland	–0.33	–0.09	–0.07	–0.08
Italy	–0.62	–0.17	–0.07	–0.12
Japan	–1.27	–0.65	–0.34	–0.57
Netherlands	–0.53	–0.19	–0.07	–0.16
Portugal	–0.68	–0.15	–0.08	–0.11
Sweden	–0.39	–0.14	–0.06	–0.16
Spain	–0.71	–0.15	–0.17	–0.09
United Kingdom	–0.74	–0.22	–0.16	–0.15
United States	–1.12	–0.35	–0.35	–0.25

Note: No shift in the budget target. Experiments conducted in one country at a time.

In order to determine the effects of an *ex ante* change in fiscal policy one has to avoid offsetting or reinforcing policy effects, but the model must otherwise be allowed to run. In each of our simulations in this section we make the following assumptions:

- Policy reactions are turned off for the first year:
  - The central bank does not change the short-term interest rate for a year, whatever the shock. It then follows a targeting regime that stabilises either the inflation rate or the price level.
  - The government does not target the deficit for the first year. The model has a feedback rule which adjusts the direct tax rate in relation to the gap between actual and target deficits. This is switched off for a year.
  - Government investment is fixed at the baseline for a year and does not respond to long-term factors in the first year. The same, where this is appropriate, is true for government consumption.
  - Other tax rates and all benefit replacement rates are held constant throughout the simulation period.
- Markets work and all quantities and prices can react and there are no exogenous variables in the model, with the exceptions of policy targets, labour supply and risk premia:
  - Financial markets look forward and are assumed to follow arbitrage paths, and expectations for those paths are outturn consistent.
    - Long-term government bond rates are the forward convolution of future short-term policy rates plus an exogenous premium.
    - Long-term real interest rates are the forward convolution of future short-term real policy rates plus an exogenous risk premium made up of the bond premium plus private sector risks.
    - Equity prices are the discounted value of future profits, where the discount factor is the market interest rate plus the exogenous equity premium.
    - Exchange rates "jump" when future interest rates change and they follow the arbitrage path given by nominal interest rates.
  - Labour markets are described by an exogenous labour supply, a labour demand equation and by a wage equation based on search theory, where the bargain depends on backward and forward looking inflation expectations.
  - Capital stocks adjust slowly towards that associated with expected capacity output four years ahead, which in turn depends upon a forward looking user cost of capital. Expectations are rational and factor demands and capacity output are based on a CES production function.
  - Consumers respond to their forward looking financial wealth, but are not fully forward looking.

In the next sections, the implications of several of these default assumptions will be tested.

Table 1 reports the estimates of the first year multipliers for 18 OECD countries, under the default assumptions described above, for a 1% (*ex ante*) GDP fiscal contraction – a rise in taxes or cut in spending that is reversed after one year. The multipliers for cuts in government consumption spending and spending on benefits are reported, as well as for rises in indirect taxes and direct (personal) taxes. Simulations are run one country at a time,

so there are no spillovers across countries in the reported multipliers. Generally multipliers peak in the first year and then decline, and the *ex post* improvement in government revenues will normally be less than 1% of GDP as tax bases change. Some of the effects of the impulse will be offset by declines in interest rates. Both short and long rates should fall, but the former may be trapped at the lower bound at present. Even when short rates are trapped at the lower bound, forward-looking long rates can fall as long as they retain some downward flexibility. In NiGEM, investment behaviour is mainly influenced by long real rates through the user cost of capital, and as long as these are free to fall in response to a temporary fiscal tightening, the impact of hitting the zero bound in short rates will be limited.

The multipliers reported in Table 1 illustrate some of the key differences across fiscal instruments, and also highlight important differences across countries. Government consumption spending multipliers tend to be larger than tax or benefit multipliers, as a fraction of any disposable income change is absorbed through a temporary adjustment to savings. However we should bear in mind the caveat mentioned above that it is not necessarily feasible to cut the provision of government goods and services at short notice. The effects of government investment and corporate taxes will not be investigated in this study.[2]

1.2. Structure of the economy

Country size is an important distinguishing factor across country multipliers, as the long term fall in real interest rates that is produced by consolidations is an international phenomenon. When capital moves freely between countries, real interest rates are determined largely by the balance between global saving and global investment, and large countries such as the United States have much more impact than small ones such as Greece. In addition, the initial interest rate response will be smaller in countries in EMU because the ECB responds to euro area inflation.

Multipliers tend to be smaller in more open economies, because the more open an economy is the more of a shock will spread into other countries through imports, and small open economies such as Belgium have small multipliers. Another structuring factor is the degree of dependence of consumption on current income. This is often related to liquidity constraints, with a higher current-income elasticity more common in financially unliberalised economies such as Greece than in Belgium or the United States. Finally, the speed of response of the economy depends in part on the flexibility of the labour market and the speed at which policies, such as a rise in VAT feed into prices.

Table 2 compares the temporary government consumption spending and direct tax multipliers from Table 1 with some of the key factors determining the differences in the magnitude of multipliers across countries: country size (measured at 2005 PPPs), import penetration (measured as the volume of imports of goods and services in 2005 as a share of GDP) and the estimated short-term income elasticity of consumption. At the bottom of the table, the correlations between each factor and the two multipliers are reported. The largest estimated multipliers are found in Japan, the United States and Greece. For Japan and the United States this is largely a reflection of the low level of import leakages, with imports amounting to just 10-15% of GDP. Import penetration is also relatively low in Greece, given the size of the economy, while the estimated short-term income elasticity of consumption is higher than in most of the other economies in the sample, and both factors increase the estimated multiplier.

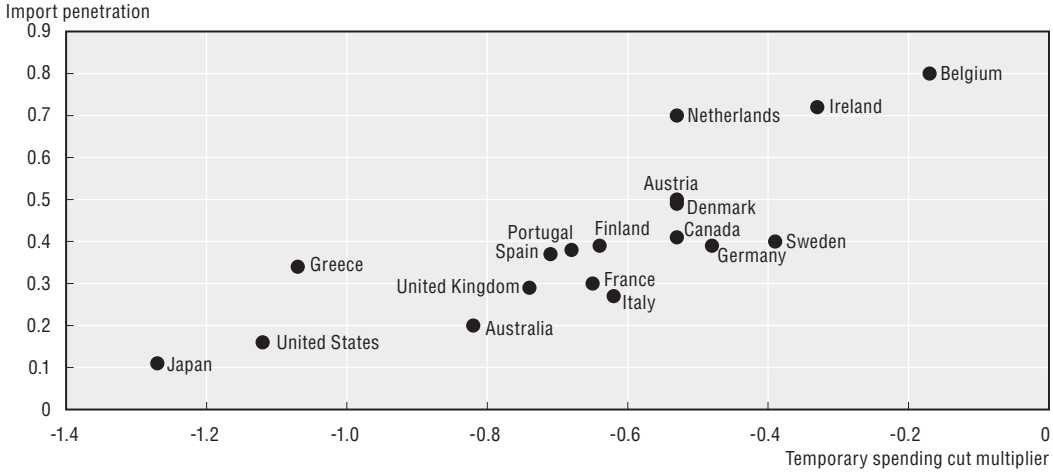
Table 2. **Key factors determining cross-country differences in multipliers**

	Temporary spending cut multiplier	Temporary income tax rise multiplier	2005 GDP (PPPs)	Import penetration	Short run income elasticity
Australia	–0.82	–0.22	696	0.20	0.23
Austria	–0.53	–0.13	279	0.50	0.23
Belgium	–0.17	–0.03	337	0.80	0.17
Canada	–0.53	–0.12	1 132	0.41	0.17
Denmark	–0.53	–0.04	181	0.49	0.00
Finland	–0.64	–0.08	160	0.39	0.00
France	–0.65	–0.27	1 869	0.30	0.51
Germany	–0.48	–0.27	2 512	0.39	0.68
Greece	–1.07	–0.32	278	0.34	0.48
Ireland	–0.33	–0.08	159	0.72	0.17
Italy	–0.62	–0.12	1 634	0.27	0.14
Japan	–1.27	–0.57	3 873	0.11	0.24
Netherlands	–0.53	–0.16	572	0.70	0.23
Portugal	–0.68	–0.11	217	0.38	0.08
Sweden	–0.39	–0.16	300	0.40	0.22
Spain	–0.71	–0.09	1 184	0.37	0.00
United Kingdom	–0.74	–0.15	1 933	0.29	0.17
United States	–1.12	–0.25	12 638	0.16	0.15
Spending correlation			–0.55	0.81	–0.08
Tax correlation			–0.39	0.63	–0.54

Note: Consumption and direct tax multipliers from Table 1. Import penetration is measured as the volume of goods and services imports as a share of GDP in 2005. Income elasticity is the estimated response of consumption to current changes in income, from the consumption equations in NiGEM (see Appendix for details).

Across all the countries in the sample, the correlations indicate a 40-55% correlation between country size and the tax and spending multipliers, suggesting that the larger the economy the bigger the multiplier. The large economy impact on world interest rates must be more than offset by other features of large economies, such as the tendency to be less open to imports than the smaller economies, as the interest rate change in response to a temporary shock is very small. Import penetration has a very strong correlation with the impact multipliers, suggesting that more open economies tend to have smaller multipliers, both in response to spending cuts and tax rises. Figure 1 illustrates the strength of this correlation with the temporary spending on goods and services multiplier.

Figure 1. **Temporary spending cut multiplier and import penetration**



The short-term income elasticity of consumption has little relationship with the first year government consumption multipliers, as government consumption is a direct component of GDP, and the impacts on GDP via the household consumption channel are secondary. However, this elasticity shows a 50% correlation with income tax multipliers, which feed directly into personal income, and affect GDP through the household consumption channel. The indirect tax and benefit multipliers will also depend upon the short-term relationship between income and consumption. An indirect tax increase reduces real income, and the extent to which this feeds into GDP is directly related to the short-term income elasticity of consumption. Similarly, benefit payments are a component of income, and affect GDP through the consumption channel, so first-year multipliers for these instruments will also be sensitive to the short-term income elasticity of consumption.

Fiscal multipliers are clearly sensitive to the short-term income elasticity of consumption, which is commonly associated with the severity of borrowing constraints within the economy. However, access to credit is dependent both on credit history and on current income, and so is necessarily sensitive to the state of the economy. As unemployment rises, a greater share of the population will be unable to access credit at reasonable rates of interest – at precisely the moment when they are in need of borrowing to smooth their consumption path. This means that consumption is likely to be cyclical, and that the income elasticity is likely to be time varying and dependent on the position in the cycle. Following a banking crisis the effects can be expected to be particularly acute, as banks tighten lending criteria, as discussed by Barrell, Fic and Liadze (2009). This also suggests that fiscal multipliers are dependent on the state of the economy – especially tax innovation multipliers – and this is consistent with recent studies such as Delong and Summers (2012) and Auerbach and Gorodnichenko (2012).

The consumption equations[3] underlying the multiplier estimates reported in Table 1 are modelled as:

$$\begin{aligned}\Delta \ln(C_t) = \lambda\{\ln(C_{t-1}) - [a + b_0 \ln(TAW_{t-1}) + (1-b_0)\ln(RPDI_{t-1})]\} \\ + b_1 \Delta \ln(RPDI_t) + b_2 \Delta \ln(NW_t) + b_3 \Delta \ln(HW_t)\end{aligned} \quad (1)$$

where *C* is consumption, *TAW* is total asset wealth, which is the sum of net financial wealth (*NW*) and tangible wealth (*HW*), *RPDI* is real personal disposable income, Δ is the difference operator, and the remaining symbols are parameters. The share of the population that is liquidity constrained will affect the short-term income elasticity of consumption, given by parameter b_1. Al Eyd and Barrell (2005) discuss this further.

In order to assess the sensitivity of fiscal multipliers to this parameter, we calibrate the income tax multiplier under a series of eleven different models, allowing the parameter b_1 to rise incrementally. We illustrate the sensitivity using the United States as an example. When b_1 is equal to 0, this implies perfect capital markets with no liquidity constraints and consumer spending will be largely invariant to short-term fluctuations in income. When it is equal to 1 this implies that consumption is fully reliant on current income, with no scope for saving and smoothing consumption. In our standard model, the estimated parameter for b_1 in the United States is given by 0.15, suggesting a relatively low level of liquidity constraints historically, although as Table 2 illustrates this is not out of line with other advanced economies in an internationally comparative context. The estimated fiscal multipliers of income tax innovations under different assumptions on the short-run income elasticity of consumption are reported in Table 3. With no liquidity constraints, we would expect a fiscal multiplier of just 0.1% in the first year, while with no options for borrowing to smooth

Table 3. **First year income tax rise multiplier in the United States, under different short-term income elasticities of consumption**

Model	Short-run income elasticity of consumption (b_1)	Impact on GDP year 1
1	0.0	–0.11
2	0.1	–0.20
3	0.2	–0.29
4	0.3	–0.39
5	0.4	–0.50
6	0.5	–0.62
7	0.6	–0.75
8	0.7	–0.89
9	0.8	–1.04
10	0.9	–1.21
11	1.0	–1.38

consumption we would expect output to decline by 1.4%. These differences are confined to the short to medium term, and are expected to dissipate gradually over 5-7 years. This illustrative example for the United States can be used as a guide for other countries, as to the sensitivity of multiplier estimates to these key parameters.

Country size, openness and the income elasticity of consumption are some of the key factors that determine the size of the fiscal multiplier, but of course these are not the only factors. Model-based multiplier estimates will depend on the full set of equations and estimated elasticities underlying each country model. Equation dynamics are particularly important when looking at the longer term profiles, and we explore the sensitivity of multiplier profiles to key equations in the section on longer-term multiplier profiles below.

1.3. Permanent fiscal innovations

A permanent fiscal consolidation also involves changing the budget deficit target. The reported multipliers in Table 4 are based on the same set of shocks applied in Table 1, but with the cut in spending or increase in taxes being permanent and the deficit target is shifted by 1% of GDP. This changes the shape of the multiplier, as income taxes will rise in all scenarios from the second year of the simulation to cover any shortfall in the 1% of GDP consolidation, and long-term interest rates will fall by more than for a temporary consolidation. The impact of tax increases in the second year varies across shocks, depending on the degree of shortfall in the *ex post* budget improvement compared with the *ex ante* estimates.

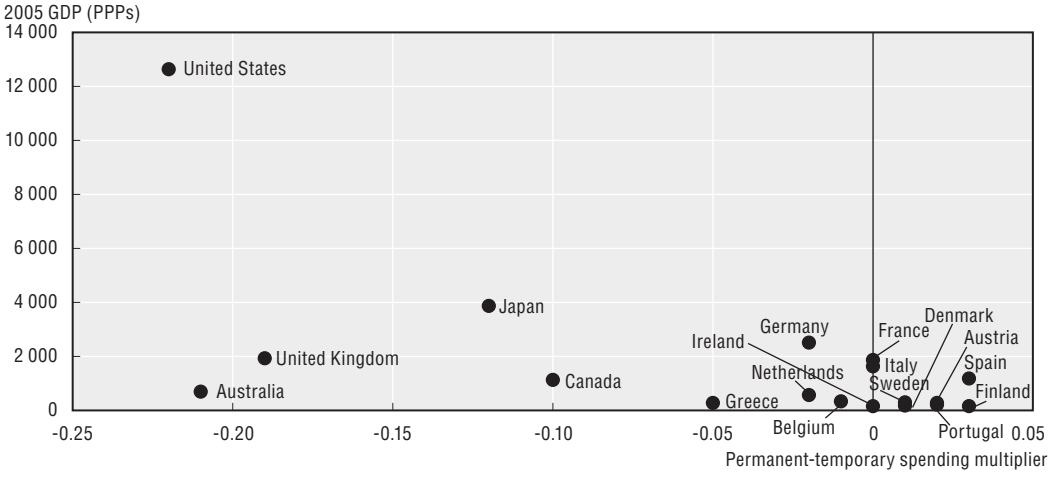
In general, permanent multipliers should be smaller than temporary ones, as the impact of the fiscal contraction on long rates will be larger, and the fall in long rates will induce increases in asset prices and in investment.[4] Country size plays a much more direct role in determining the offset on a permanent consolidation relative to a temporary one than in determining the size of the multiplier itself. Figure 2 plots the difference between the permanent government consumption multipliers reported in Table 4 and the temporary multipliers from Table 1, against our measure of economy size. There is a 60% correlation between the series, with large countries such as the United States, which has an important role in determining global interest rates, seeing a much bigger decline in the magnitude of the multiplier when the consolidation is permanent than do small EMU countries such as Finland where monetary policy is not independent. The five countries

Table 4. **First-year multipliers from 1% of GDP permanent consolidation**

	Government spending		Taxes	
	Consumption	Benefits	Indirect	Direct
Australia	–0.61	–0.17	–0.32	–0.12
Austria	–0.55	–0.18	–0.05	–0.13
Belgium	–0.16	–0.04	–0.02	–0.03
Canada	–0.43	–0.13	–0.10	–0.08
Denmark	–0.54	–0.10	–0.02	–0.05
Finland	–0.67	–0.16	–0.05	–0.10
France	–0.65	–0.33	–0.11	–0.26
Germany	–0.46	–0.29	–0.12	–0.25
Greece	–1.02	–0.44	–0.29	–0.37
Ireland	–0.33	–0.11	–0.06	–0.08
Italy	–0.62	–0.17	–0.06	–0.12
Japan	–1.15	–0.58	–0.43	–0.48
Netherlands	–0.51	–0.19	–0.05	–0.15
Portugal	–0.70	–0.17	–0.06	–0.12
Sweden	–0.40	–0.17	–0.05	–0.13
Spain	–0.74	–0.17	–0.16	–0.12
United Kingdom	–0.55	–0.14	–0.14	–0.08
United States	–0.90	–0.25	–0.27	–0.16

Note: Budget target shifted by 1% of GDP. Simulations conducted in one country at a time.

Figure 2. **Permanent and temporary spending multipliers against economy size**



with the largest differences between temporary and permanent multipliers all have independent monetary policies and hence a fiscal contraction will induce a larger decline in long rates and in the exchange rate than is observable in the countries within EMU.

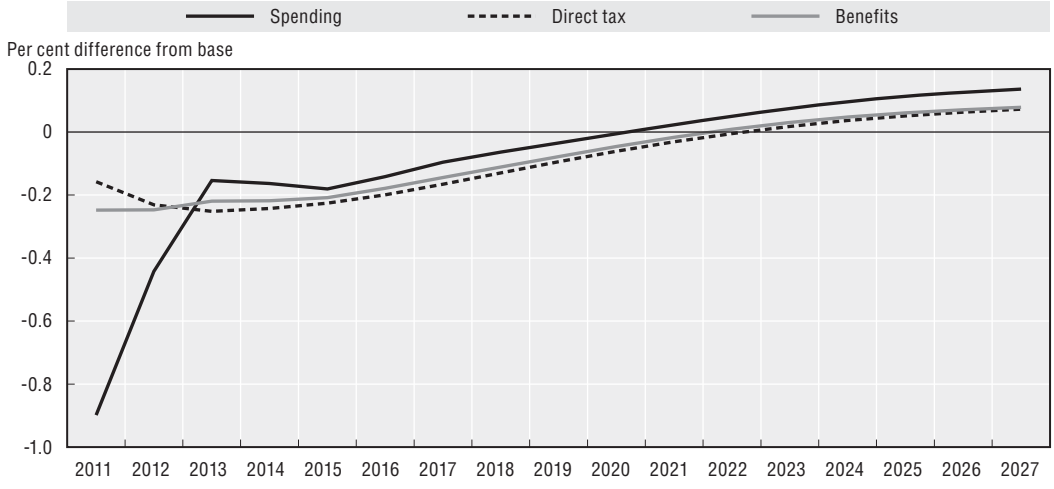
2. Longer-term multiplier profiles

This section goes beyond the short-run impact multipliers discussed above, and considers the longer-term impact of a permanent consolidation on output, and the dynamic path of adjustment. The use of the term multiplier is probably a misnomer in this context, but we will use it, rather than the more cumbersome "effect on the path to equilibrium". The first-year impact multipliers discussed in the previous section illustrate the expected negative impact on output in the short-term in response to a fiscal tightening. Without a

simultaneous shock to the supply side of the economy, the demand shock will dissipate over time, bringing the level of output back towards its long-run equilibrium. The transmission mechanisms that allow output to recover are primarily through the financial markets and price adjustment. The contraction in demand leads to job losses and puts downward pressure on the price level. Higher unemployment leads to more moderate wage settlements, strengthening the disinflationary pressures. This allows interest rates to come down and a depreciation of the exchange rate, which in turn stimulate investment and net trade. While there will be a shift in the composition of demand (from the public to the private sector, or from consumption to investment and net trade) the level of output should return to base. In general, in large economies output should rise marginally in the long run in response to a fiscal consolidation in that country alone, as real interest rates will eventually be lower. This raises the desired level of the capital stock and thus potential output over the longer term. The profiles for a number of countries are reported, and each starts with the impact multipliers in Table 4.

As one can see from Figure 3, output in the United States returns to the baseline relatively quickly after a cut in spending and a shift in the deficit target. In this simulation interest rates fall to zero only in the first quarter, and they are not trapped at that level, although this would be a common experience if the shock were larger. We omit the time paths for indirect taxes as they involve a rise in prices and the pattern depends upon the monetary policy response in a way the others do not. In general interest rates rise in response to inflation induced by tax rises in order to keep expectations in check, and the scale of the increase will affect the path of output, and it will depend upon the rule in place. Benefits multipliers are initially larger than tax multipliers because more benefit recipients are liquidity constrained than the average of the population.

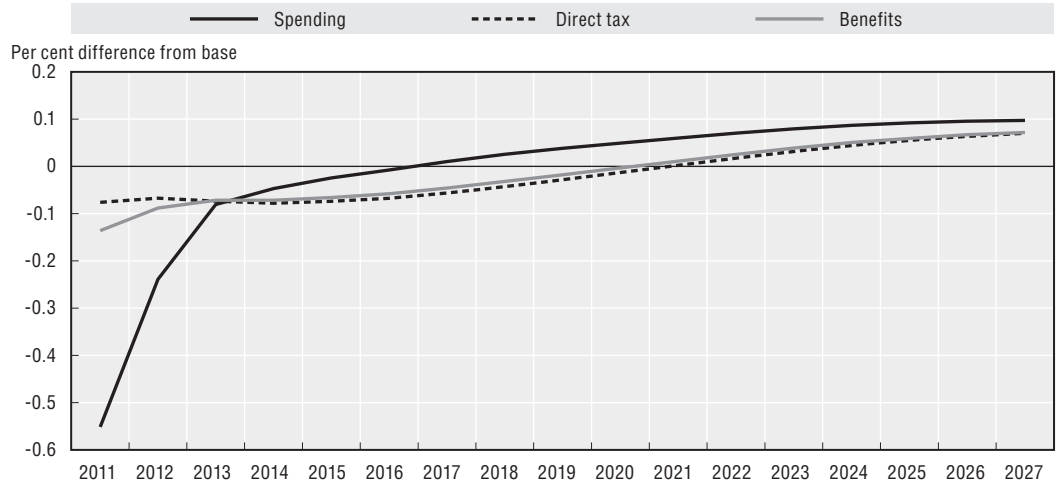
Figure 3. **Permanent consolidation multipliers in the United States**



Note: The figure shows the deviations from baseline following a permanent fiscal shock.

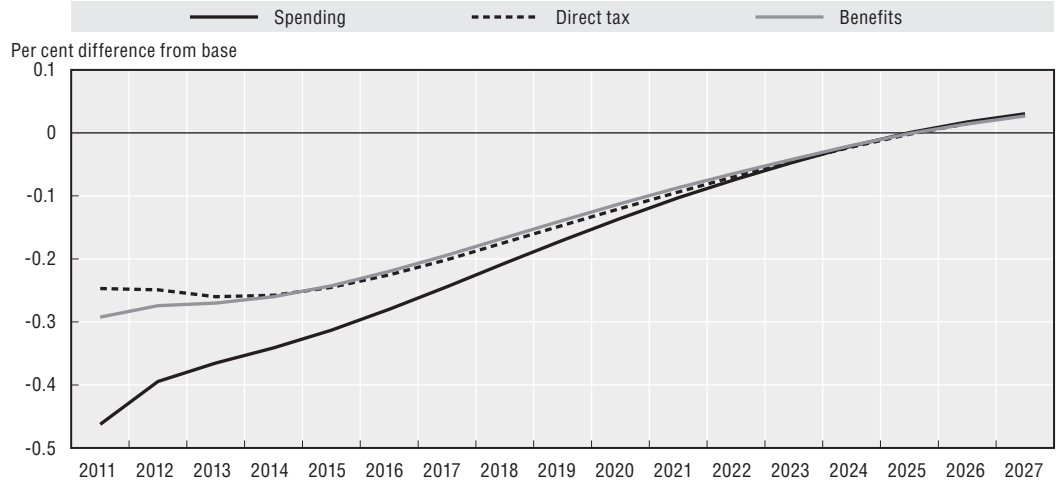
Consolidation paths for the United Kingdom and the Netherlands (Figures 4 and 7) are similar to those for the United States, with markets working more rapidly than in France or Germany (Figures 5 and 6), where equilibrium is regained more slowly. This reflects both larger effects from current income in German consumption and slower reactions of real wages per person hour to unemployment. The former reflects the estimated consumption

Figure 4. **Permanent consolidation multipliers for the United Kingdom**



Note: The figure shows the deviations from baseline following a permanent fiscal shock.

Figure 5. **Permanent consolidation multipliers for Germany**

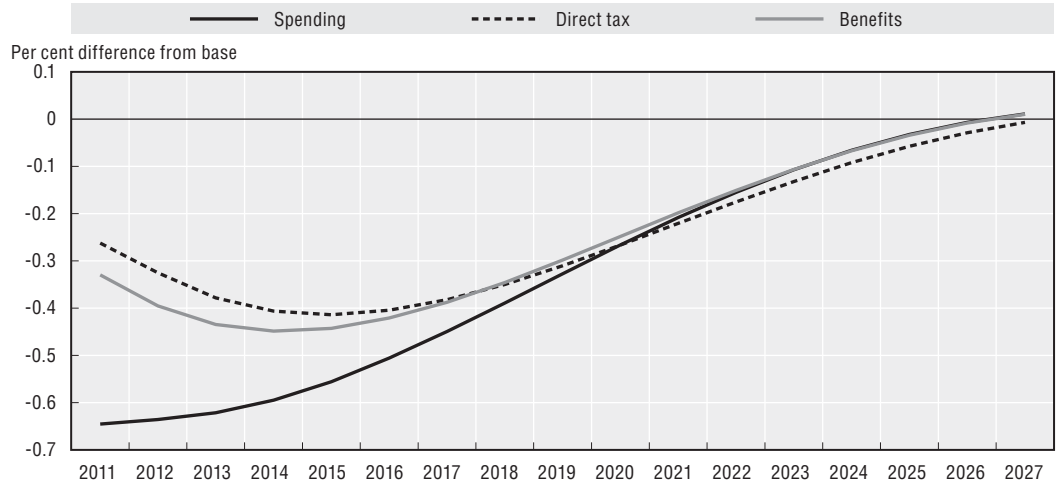


Note: The figure shows the deviations from baseline following a permanent fiscal shock.

function based on the approach used in Barrell and Davis (2007)[5] whilst the latter reflects estimated labour demand and wage relationships. There is also less of an offsetting effect from declines in the exchange rate in the short term, and the inertia in the unemployment process in both countries, as in much of the rest of Europe, would mean total benefits would be higher in the medium term. In addition in Germany benefit recipients are more likely to be liquidity or borrowing constrained as compared with average taxpayers. The tax rule implies that this would be recouped by higher taxes on incomes and hence output growth would slow. This profile is only present in a permanent consolidation multiplier, as the effects are a combination of the shock to spending and the shock to the budget target.

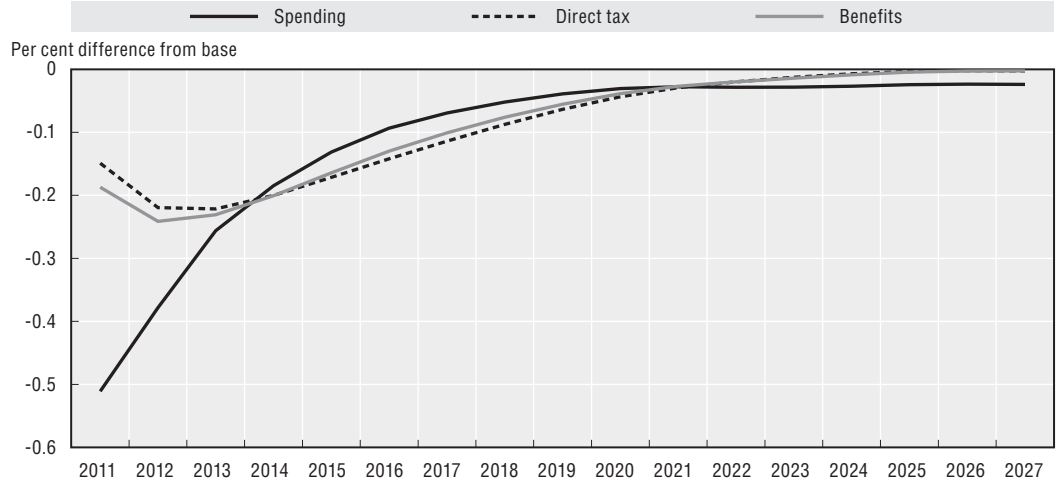
Figure 8 disaggregates the differences between the longer-term multiplier profiles for Germany and the United States in response to a government consumption-based consolidation into the parts that can be attributed to differences in specific estimated equations for the two countries, and the part that is due to differences in key data ratios. The

Figure 6. **Permanent consolidation multipliers for France**



Note: The figure shows the deviations from baseline following a permanent fiscal shock.

Figure 7. **Permanent consolidation multipliers for the Netherlands**



Note: The figure shows the deviations from baseline following a permanent fiscal shock.

lines designated as German model/Germany data and US model/US data correspond to the spending multipliers for Germany and the United States in Figures 5 and 3 above. We start by replacing the import and export equations for Germany with those used in the US model, and rerun the German spending shock. This slightly increases the short-term multiplier, and speeds the adjustment back to base. We go on to replace the wage equation for Germany with that used in the US model, then the consumer price equation, then the producer price equation, and finally all the model equations (US model/German data). The differences between this final simulation (US model/German data) and the US model/US data can be attributed to key data ratios, such as the openness of the economy and the wealth to income ratio as well as the composition of wealth between interest sensitive equities (more in the United States) and bank accounts (more in Germany). Data ratios are clearly important for determining the magnitude of the short-run impact multiplier, while the speed of adjustment back to base is more closely connected to the parameter estimates of individual equations.

Figure 8. **Permanent spending cut multipliers for Germany under different equations**

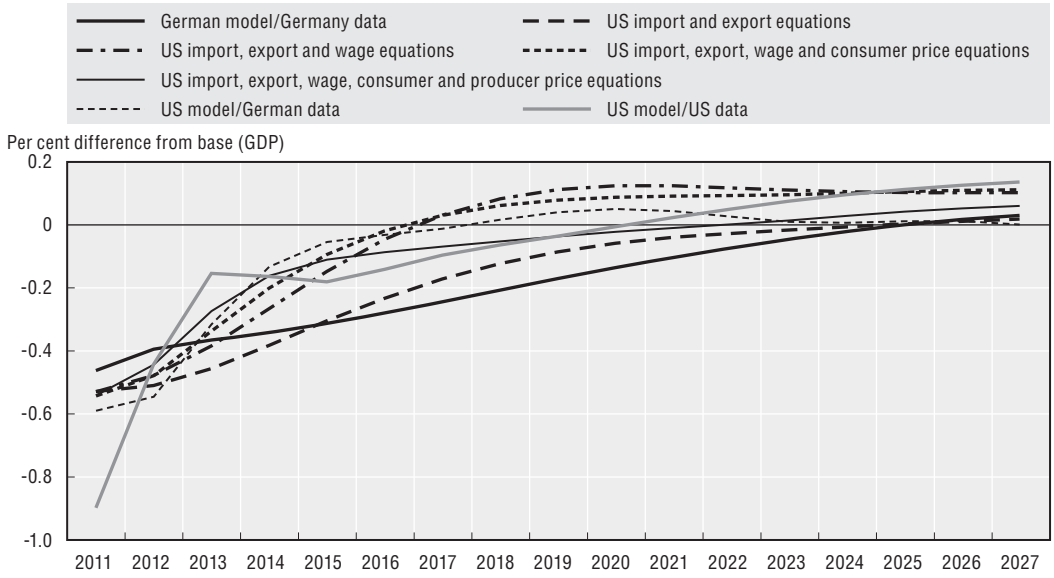
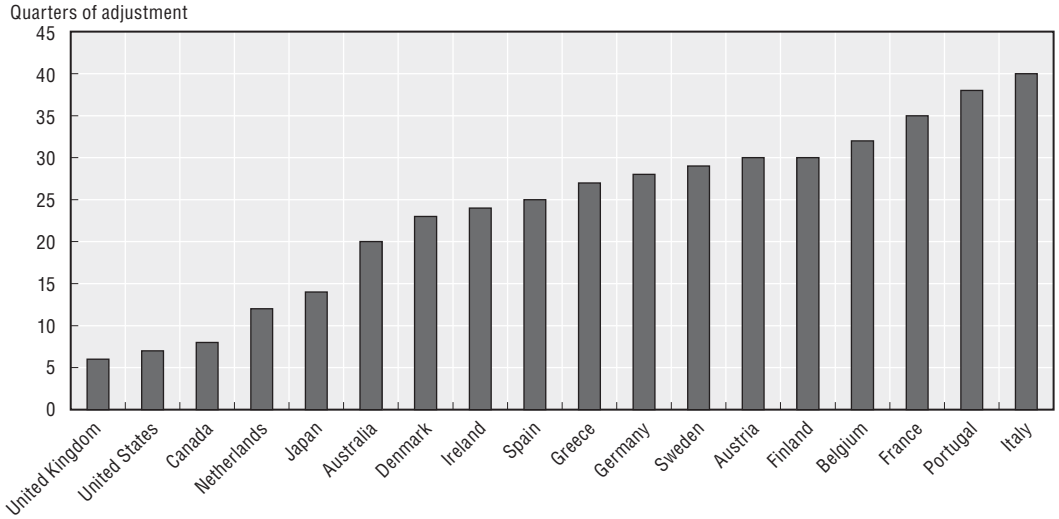


Figure 9 puts the other countries covered by this study into context with the dynamic adjustment paths illustrated above. This indicates the number of periods needed to allow half of a fiscal consolidation effected through a cut in government spending to dissipate. Canada and the Netherlands tend to behave more like the United States and the United Kingdom, and adjust relatively rapidly in response to a shock, whereas Italy, Portugal and Belgium are more sluggish, with a dynamic adjustment path more in line with that observed in France.

Figure 9. **Quarters of adjustment**



Note: The figure shows the "half-life" of a government spending shock, *i.e.* the number of quarters for half of the shock to GDP to dissipate.

The long-run multipliers are based on the assumption of an exogenous labour supply. If one were to allow an endogenous response of labour supply to either a rise in the income tax

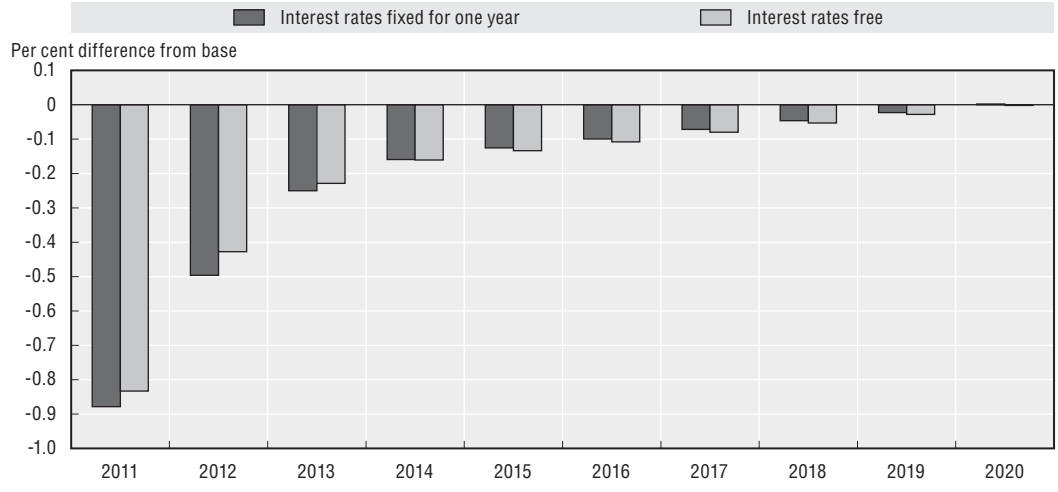
rate, which may reduce incentives to enter the labour force, or a decline in the benefit rate, which may increase incentives to enter the labour force, this would result in a permanent shift in potential output. The magnitude of the impact would depend on the assumed elasticity of labour supply to the tax and benefit rates.

3. Monetary policy response and the fiscal multiplier

The fiscal multipliers reported in Tables 1 and 3 and illustrated in Figures 3 to 7 above are based on the series of assumptions detailed above. However, multipliers are not immutable, and in the next two sections the implications of some of these assumptions will be assessed, and the impact on the estimated multipliers from adopting an alternative set of assumptions reported. In this section the focus is on the choice of the monetary policy response to a fiscal consolidation. We use the United States as an example, but similar results can be expected in other large advanced economies.

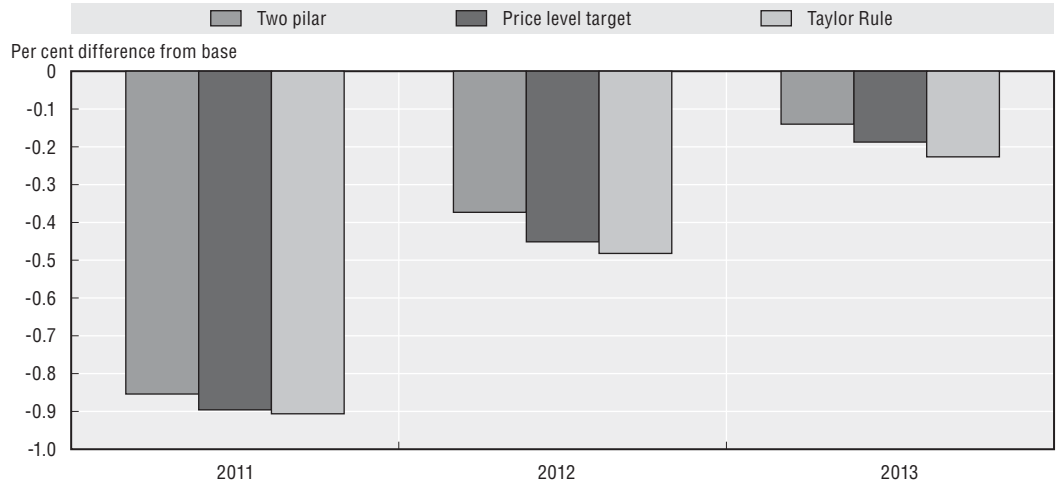
Under the default assumptions, nominal short-term interest rates are initially fixed for one year. Thereafter, the monetary authority is assumed to follow the standard feedback rule, which applies a combined target to both inflation and a nominal aggregate. If one allows interest rates to respond immediately, the monetary authority will cut interest rates in the first year to offset part of the contractionary impact of the fiscal consolidation. This reduces the fiscal multiplier slightly in the first three years, as illustrated in Figure 10, but raises it slightly in subsequent years, so that the net cumulative impact of this speed of interest rate response is negligible.

Figure 10. **US government consumption cut multipliers – different initial reactions**



Next the implications of the monetary authority having a different targeting regime in place are assessed. In Figure 11, the multiplier under the standard two-pillar rule applied in the previous simulations is illustrated, and compared with the estimated multipliers when a Taylor Rule is applied and when a price level target is applied. The impact on GDP is largely similar across the three feedback rules, suggesting that the chosen target itself is less important than the speed with which the response is implemented. The shock is deflationary and takes prices and output below their baseline initially, inducing a cut in interest rates under all three rules. The impact on long rates is least when a Taylor Rule is used, as this is a proportional feedback rule that is designed to take the inflation rate back

Figure 11. **US government consumption cut multipliers – under different monetary policy feedback rules**



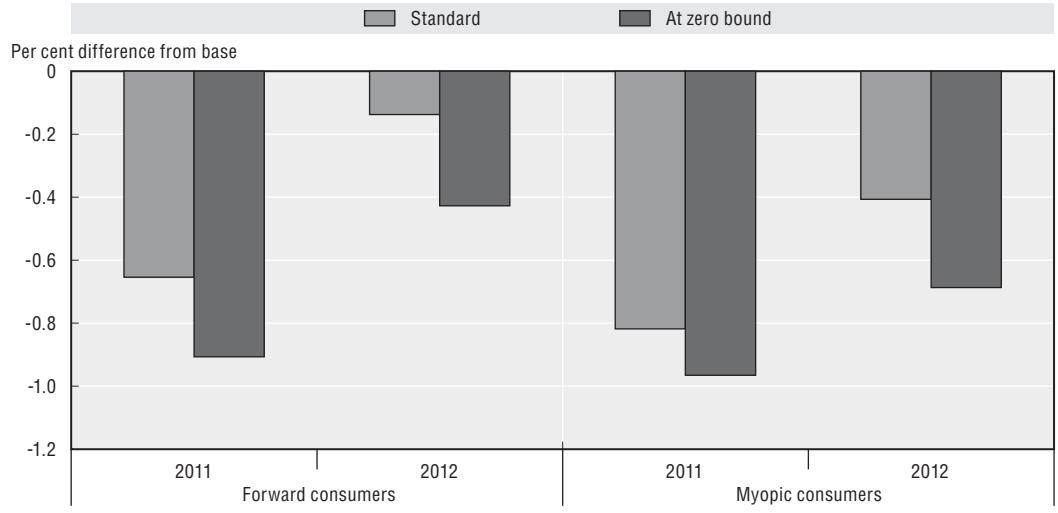
Note: The figure shows the deviations from baseline. Two pillar is when monetary policy targets both the inflation rate and a nominal aggregate.

to target after it has fallen below it. A price level rule, as implemented here, is a proportional, integral controller and targets the inflation rate as well as the price level. As the consolidation shock reduces the price level the rule induces a larger cut in interest rates than would a proportional controller in order to take prices back to target.[6] A two pillar rule feeds back on nominal GDP and inflation, and hence with the same parameters reduces interest rates more as nominal GDP falls by the fall in prices relative to base plus the fall in output relative to base. Hence the offset to a fiscal contraction is greatest with an ECB style two pillar strategy and least with a Fed style Taylor Rule.

3.1. Impaired interest rate channel – the zero bound

It may of course be the case that monetary policy cannot react immediately because interest rates are at, or close to, zero. The Federal Reserve, and other major Central Banks, cut interest rates to near zero levels in 2009. More recently, the Federal Reserve has announced that these exceptionally low levels of interest rates are expected to remain warranted until mid-2015. This suggests that there is limited scope for monetary accommodation of the fiscal consolidation programme in the near term. We consider the impact on the first-year fiscal multiplier of a fiscal innovation introduced during a period like the present, where there is little scope for downward flexibility in interest rates for five years. This is compared with the estimated multiplier with full downward flexibility in interest rates. We compare the impacts under the assumptions of forward looking consumers and myopic consumers. Forward looking consumers (discussed further below and in the Appendix) take the net present value of their future incomes and spend in relation to this. With downwardly flexible interest rates, a fiscal consolidation reduces interest rates in the short term and hence consumption rises as a result. At the zero bound interest rates cannot fall (for at least five years in our experiment) and hence consumption does not absorb as much of the shock and output falls by ¼ percentage points more than in the normal case with forward looking consumers. In NiGEM myopic consumers are less influenced by short-term interest rates and investment decisions depend upon the user cost of capital. Hence the zero bound raises the multiplier by less if consumers are myopic, as can be seen from Figure 12. In this case, the binding zero bound on interest rates raises the impact on output in the first year by

Figure 12. **Impact of the zero lower bound on interest rates on the US government consumption cut multiplier**



Note: Forward consumers use forward-looking model-consistent expectation whereas myopic consumers are backward looking. The standard scenario allows for full downward flexibility in short-term interest rates, while the alternative scenario assumes short rates have no downward flexibility for five years.

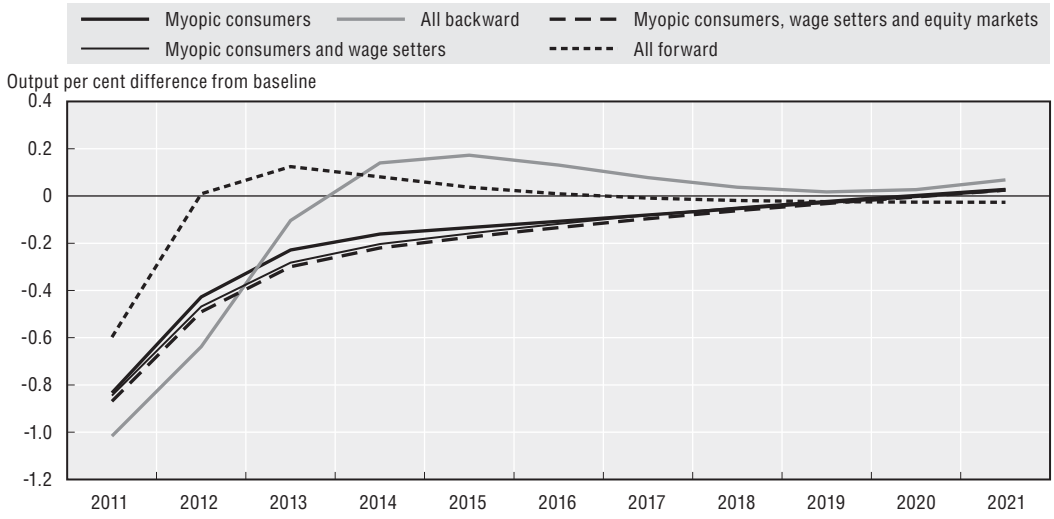
0.15 percentage points. Both scenarios allow for downward flexibility in long-term interest rates. If these were also constrained, the negative consequences for output would be much more severe in the short term.

4. Fiscal multipliers and expectations

Perhaps the most important set of assumptions affecting the size of the multiplier concern the role of expectations. In the standard set of simulations, the assumption is made that financial markets are forward looking. Long-term interest rates, equity price and exchange rates follow a forward-looking arbitrage path, which is consistent with the simulation outturns. Wage setting is also partly forward looking, with wage settlements driven by a weighted average of current and expected inflation. Consumers are assumed to be myopic, but respond to their forward-looking financial wealth, albeit rather slowly.

In this section, some of these assumptions are relaxed in order to assess their impact on the estimated fiscal multipliers. Figure 13 shows the US multiplier in response to a permanent spending consolidation under the default assumptions (labelled as myopic consumers in the figure) and compares this with a range of alternative sets of assumptions regarding expectations. If one turns labour markets and equities backward looking so that they do not depend upon expectations about the future then the multiplier path is little affected. This is illustrated by the lines labelled myopic consumers and wage setters, and myopic consumers, wage setters and equity markets in the figure. The size of the multiplier is marginally larger under these assumptions, but not significantly so. The shock still operates with a monetary feedback rule and slower growth will reduce inflation and hence interest rates in the future will be lower. This will cause the forward-looking exchange rate to jump down and forward-looking long rates to do the same. If one turns long rates backward looking and fixes the exchange rate in the first period (and thereafter in this experiment), the multiplier in response to the consolidation programme in the United States increases to over one in the first year. This is labelled “All backward” in the

Figure 13. **The impact of expectations on the US government consumption cut multiplier**



Note: The figure shows the deviations from baseline following a permanent fiscal shock.

figure. Short-term interest rates still fall and if one did not allow this to happen then the multiplier would be marginally larger still.

One can also move in the other direction and assume consumers are forward looking and react to the expected value of their future incomes. As taxes will be lower in the future and hence the net present value of incomes is higher, consumption is initially higher with forward-looking consumers than it is with myopic ones. There is estimated inertia in the adjustment to the long run even with our forward-looking consumption equations. Reducing the mark up would shrink the multiplier further from the –0.6 in the chart, but it would still be negative. However, as the myopia premium shrinks to zero the model comes close to being fully Ricardian in that future tax liabilities are more fully taken into account.

5. Fiscal projections and uncertainty

Model-based fiscal projections and multipliers reflect our estimate of the most likely outturn in response to a fiscal consolidation plan, under a restrictive set of assumptions. The sensitivity of the results to some of these key assumptions is discussed in the previous sections. However, even in a situation where all of the underlying modelling assumptions prove an adequate description of the real world, any fiscal programme can be blown off course, and there is a degree of uncertainty attached to any projections. This partly depends on the historical volatility of key economic data and partly depends on the explanatory power of individual country models. The two are generally strongly related, but will also depend on the sample periods used in estimation for key equations, which may differ across countries, and the sensitivity of the economies to factors not explicitly modelled within NiGEM. The degree of uncertainty surrounding projections will also depend on the persistence of shocks to the economy. The latter is determined by the dynamic adjustment path of the model equations, and all else being equal countries that exhibit a slow adjustment in response to shocks (France, Italy, Portugal, for example) would be expected to have a relatively wider margin of error than those that adjust quickly (the United States and the United Kingdom, for example).

One can calculate the risks involved by undertaking stochastic simulations with NiGEM. The bounds around a baseline set of debt stock projections are reported for the major seven economies and for the four European economies that currently face heavy financial market pressure. One can also investigate the use of debt and deficit feedback rules to reduce the uncertainty around any consolidation programme.

NiGEM is a 5 000+ variable model and bootstrapping is the only available way to undertake stochastic simulations. All historical shocks were repeatedly taken from a randomly chosen "time slice" between 1995 and 2010 and applied to the model. The error structures include unexplained components from the whole period, including the severe recession in 2009. The debt stock is a stochastic process, as it has a residual, and it was applied along with the other residuals. These residuals are generally small, but for some countries they were large in 2009 and 2010. Estimated serial correlation in the errors is maintained, and for these variables it is not strong. The model is run with a set of residuals and the outturn is used in the next period when another time slice is applied in the next stage of the future history.

Table 5. **Stochastic bounds around debt stock projections in 2007**

	95%	90%	80%	Base	20%	10%	5%
Canada	88.1	85.1	81.9	75.1	67.9	64.5	62.7
France	115.1	109.6	105.0	91.5	83.1	74.7	67.9
Germany	87.9	84.5	80.3	69.0	55.4	46.9	43.7
Greece	186.3	174.5	159.8	141.9	123.7	115.4	111.5
Ireland	138.4	135.1	131.9	121.5	116.6	112.9	109.4
Italy	136.6	132.9	123.0	111.9	95.5	88.0	84.4
Japan	237.9	235.0	231.5	224.3	213.6	209.3	206.3
Portugal	130.8	127.0	119.7	110.2	98.7	93.3	89.3
Spain	97.0	94.7	90.3	84.9	78.4	73.9	71.9
United Kingdom	104.0	102.1	100.1	95.8	93.5	91.6	90.1
United States	119.1	116.2	113.6	108.8	104.4	101.1	98.8

Note: Baseline projections from NIESR July 2012 forecast.

Table 6. **Data volatility and explanatory power**

	Data volatility				Explanatory power					
	GDP	Infl.	U	Total	Cons.	Emp.	Wage	Share prices	Exports	Total
Canada	0.63	0.54	1.12	2.29	0.38	0.19	0.43	4.88	1.23	7.11
France	0.53	1.03	1.14	2.70	0.43	0.17	0.31	5.00	1.07	6.98
Germany	0.83	0.59	1.05	2.47	0.29	0.44	0.62	6.05	1.03	8.43
Greece	1.32	2.23	1.25	4.80	0.58	0.36	1.39	9.28	2.07	13.69
Ireland	2.15	2.74	3.42	8.31	0.83	0.48	0.56	5.13	1.75	8.74
Italy	0.69	1.34	1.75	3.78	0.42	0.34	0.81	5.83	1.35	8.75
Japan	1.02	0.87	0.70	2.59	0.51	0.54	0.99	5.43	1.27	8.74
Portugal	0.94	1.31	1.91	4.16	0.82	0.61	0.82	5.37	1.59	9.20
Spain	0.61	1.22	3.86	5.69	0.35	0.25	0.53	6.40	1.13	8.65
United Kingdom	0.65	1.00	1.26	2.91	0.42	0.42	0.63	3.89	1.22	6.58
United States	0.66	0.90	1.60	3.16	0.29	0.21	0.47	3.31	1.08	5.35
Average	0.91	1.25	1.73	3.90	0.48	0.36	0.69	5.51	1.34	8.39

Note: Data volatility is measured as the standard deviations of quarterly growth rates of GDP and the level of inflation and unemployment over the sample period 1992q1-2009q4. Explanatory power measured as average value of shocks applied in stochastic simulations. Totals reflect the sum of values in the preceding columns. Average is a simple average across all countries.

Stochastic simulation bounds were applied around the baselines from 2012q1 to 2028q1. For the first five years tax rates are fixed so that shock effects show up in the deficit and not in the tax rate, and hence debt stocks can rise or fall without any reaction. After 2016, tax rates respond to bring the debt stock back towards the target imposing a no-Ponzi game condition. Uncertainty bounds are plotted in Figure 14. Each figure gives the 80, 90 and 95% probability bounds around the debt stock projections. The baseline projections are discussed in the July 2012 *National Institute Economic Review*.

Table 5 gives the values of the bounds for the debts stocks as a per cent of GDP for the major seven economies and for Spain, Portugal, Ireland and Greece. In each case these are the probability bounds for the debt stock if taxes do not increase in order to keep the stock within bounds. The Greek debt stock could, on these projections lie somewhere between 111 and 186% of GDP by 2017, whilst that in Japan (on a gross basis) could lie somewhere between 206 and 238% of GDP. These bounds can be brought under control by using feedback rules (see below).

As discussed above, the stochastic bounds around the central debt projections are a combined reflections of three sources of uncertainty and volatility: the volatility inherent in key historical data series themselves; the explanatory power of the equations; and the persistence of shocks to the economy, for which Figure 9 above can act as a guide. In order to distinguish between the uncertainty related to volatility in the data and uncertainty related to the explanatory power of the model, Table 6 reports the standard deviations of three core quarterly macro series (GDP growth, inflation and the unemployment rate) and the standard deviation of the error (detrended and demeaned) on a set of key behavioural equations underlying the model that reflect the shocks applied during the stochastic runs (consumption, employment, wages, share prices and exports). The historical data for Greece, Ireland and Spain are more volatile than for other countries, whereas it is relatively stable in Canada, Germany and Japan. Even with volatile data, if the direction of volatility is predictable, it may still be possible to build a model with a high degree of explanatory power. The model with the lowest degree of explanatory power is Greece, where share price, exports and wages are all relatively poorly explained by the NiGEM equation. The model with the highest degree of explanatory power is the United States. These factors can help explain some of the differences in the error bounds around the debt profiles illustrated in Figure 14.

5.1. *Fiscal policy feedback rules*

Fiscal policy feedback rules can either respond to the deviation of the deficit (*gbr*) from its target (*gbrt*) or the deviation of the debt stock (*gdr*) from its target (*gdrt*), or both. The first would be a proportional controller, the second an integral contoller and the third a propotional and integral controller. The speed at which the debt stock returns to target depends on the choice of the rule and its parameters, as does the uncertainty around the target. The debt and deficit process is a two part one, with shocks occuring to deficits and to debts separately, as not all shocks to the debt stock (bank failures, privatisations, licence sales) affect the deficit. One can write the two equations as:

$$gbr_t = a + \lambda(gbr_{t-1} - gbrt_{t-1}) + \delta(gdr_t - gdrt_{t-1}) + \varepsilon_t \quad (2)$$

$$gdrt = gdr_{t-1} - gbrt + \omega t \quad (3)$$

Feedbacks are included in the *gbr* equation (2), and either the deficit or debt targets or both may be used. In NiGEM the instrument used is the direct tax rate, although it is also possible to use other instruments. The default value for λ is set at 0.2 and that for δ is 0,

Figure 14. **Bounds around debt stock projections**

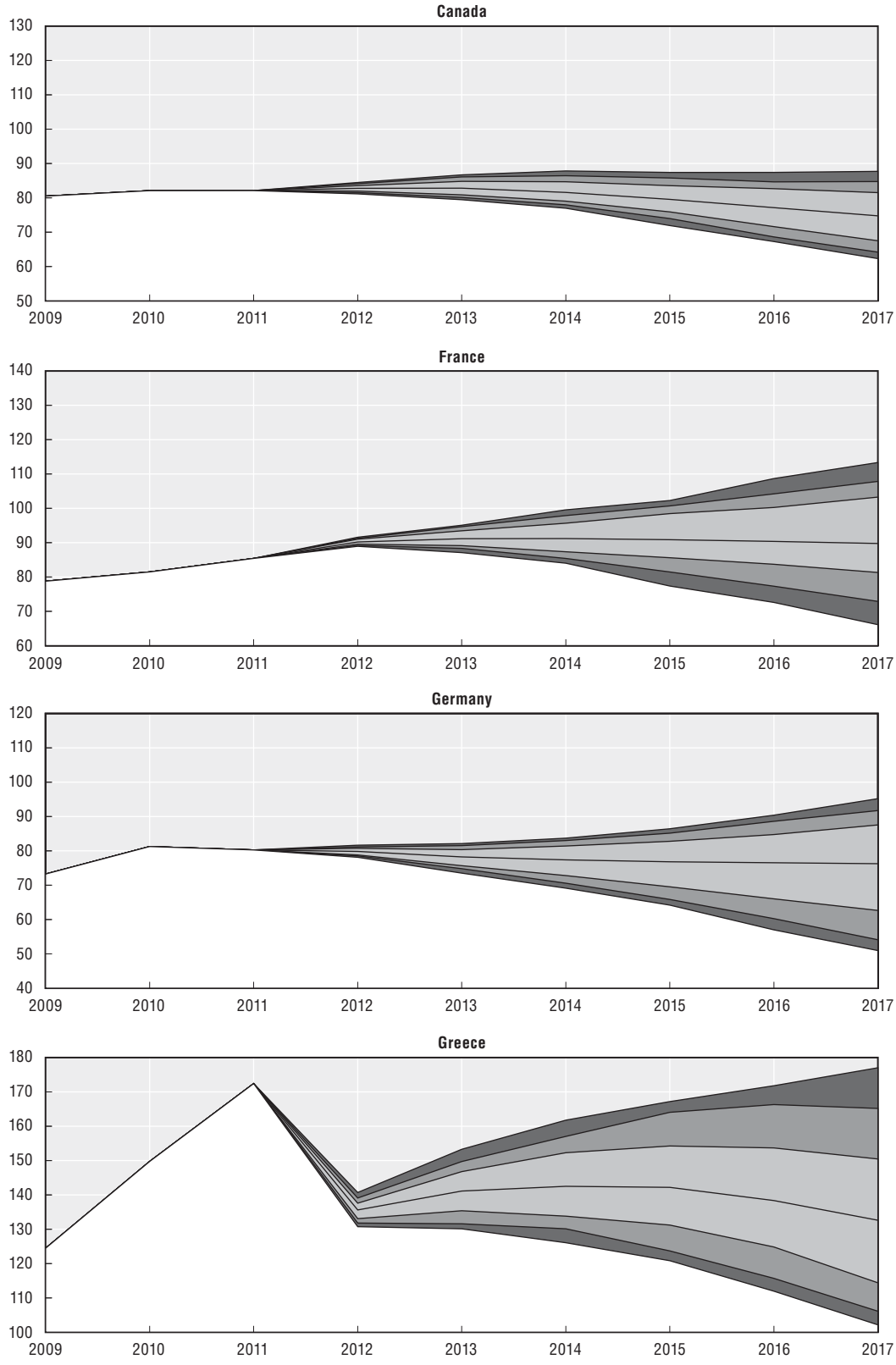


Figure 14. **Bounds around debt stock projections** *(cont.)*

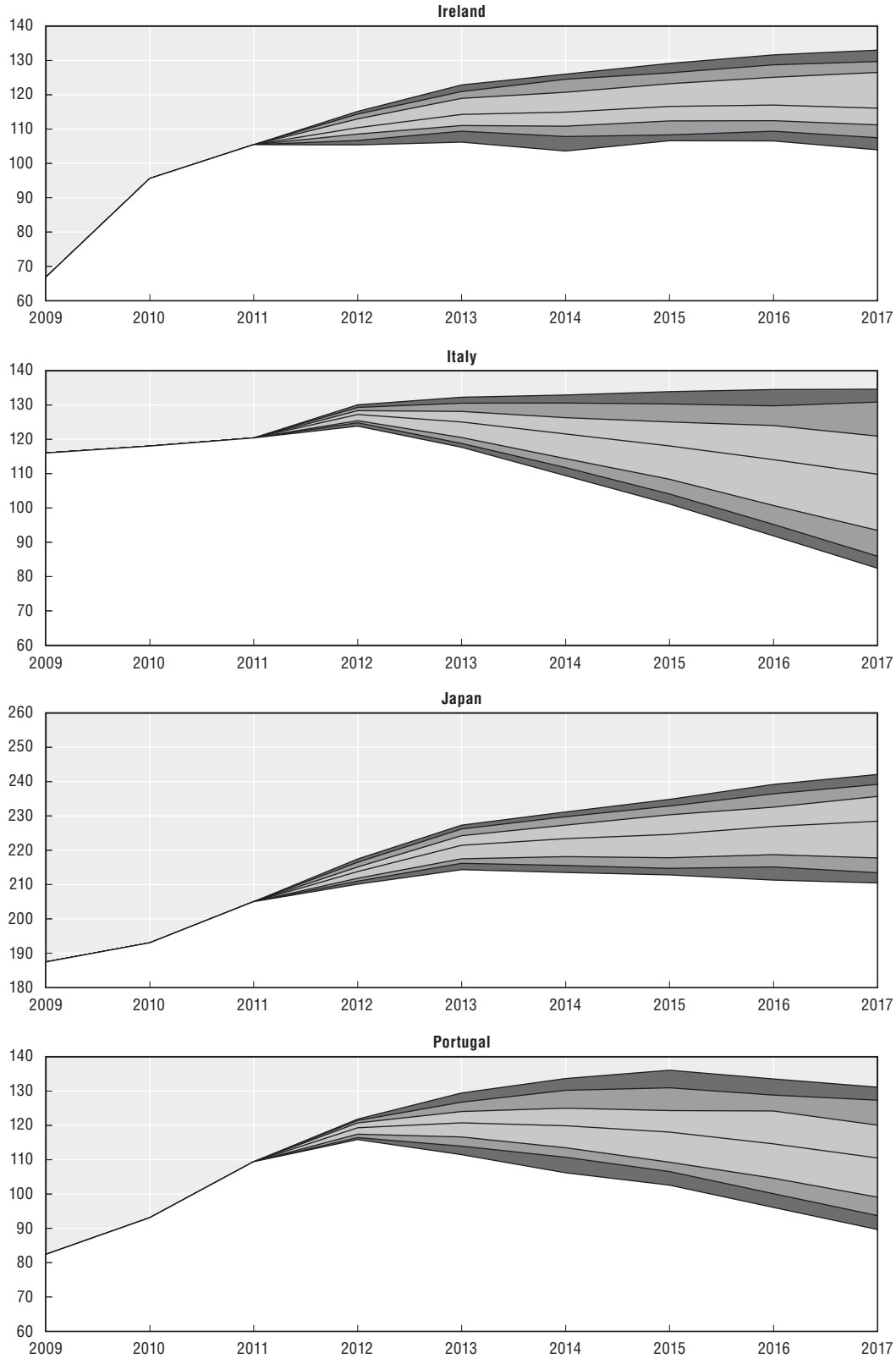
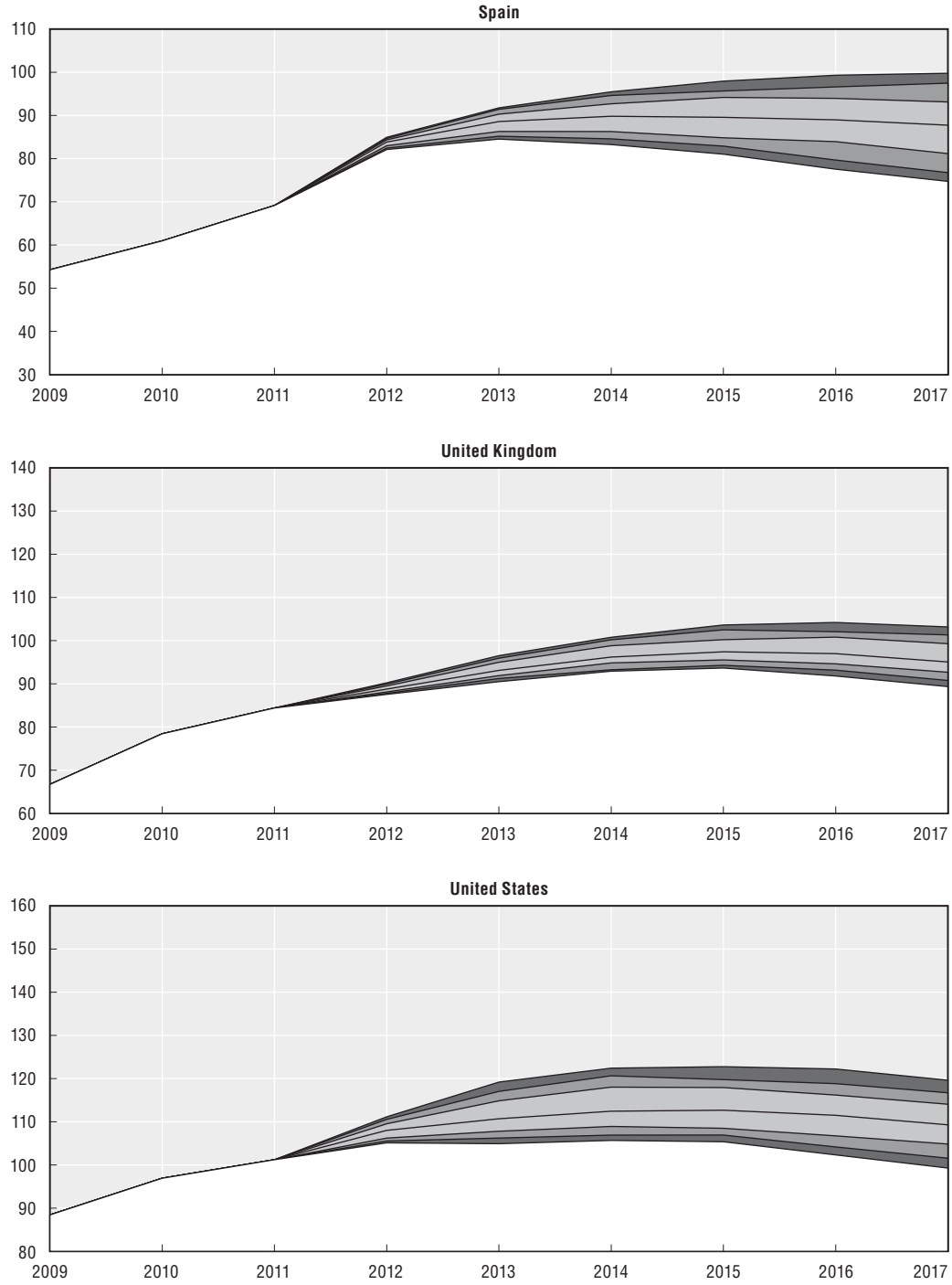


Figure 14. **Bounds around debt stock projections** *(cont.)*



Note: The figure shows the evolution of gross debt and the 60%, 80% and 90% bounds from the stochastic simulations.
Source: NIESR simulations.

with an alternate setting of 0.0025 when the debt target is active. As the process is a two part one it is possible that shocks that improve the debt stock could lead to a loosening of fiscal policy through their effects on the feedback in the deficit equation.

A spending based fiscal consolidation of 1% of GDP in all euro area countries was simulated, and stochastic bounds around the outcome calibrated under the assumption that for the first five years taxes do not rise to pull the deficit back to target. These are the no solvency rule bounds around this initial consolidation scenario, and one can compare the bounds with those from a set of rules.

As governments are interested in keeping debt stocks within bounds one can investigate the effects of feedback rules on the distance between the baseline consolidation path and the upper 95% bound in the stochastic simulation. Table 7 shows the effects of the feedback case on the upper bound as compared with the initial scenario with no feedback. A feedback of 0.0025 on the debt stock difference from target reduces the distance of the upper bound from the baseline by 3.1% of GDP on average after five years. If one doubles the feedback on the debt stock then the average distance between the baseline and the upper 95% bound declines further. The results differ between countries in part because they have different estimated parameters, but also because they have faced different historical shocks both to the factors affecting the deficit and to the debt stock directly.

Table 7. **Impacts of rules on distance of 95% bound from baseline**

	Weak GDR	Strong GDR	GBR	GBR + weak GDR	Double GBR + weak GDR
	$\lambda = 0.00$	$\lambda = 0.00$	$\lambda = 0.20$	$\lambda = 0.20$	$\lambda = 0.40$
	$\delta = 0.0025$	$\delta = 0.005$	$\delta = 0.00$	$\delta = 0.0025$	$\delta = 0.0025$
Austria	–1.33	–1.60	–1.29	–2.12	–2.48
Belgium	–0.83	–1.69	–3.05	–3.35	–3.54
Finland	–1.44	–2.65	–0.75	–1.14	–1.64
France	–0.66	–1.30	–4.27	–3.05	–3.56
Germany	–4.19	–6.63	–7.87	–8.56	–10.50
Greece	–6.16	–8.92	–10.26	–13.26	–12.35
Ireland	–5.95	–4.78	–4.71	–11.05	–10.59
Italy	–4.37	–4.29	–4.41	–6.17	–3.67
Netherlands	–1.18	–1.34	–4.15	–2.71	–4.77
Portugal	–4.15	–4.89	–7.57	–6.67	–7.37
Spain	–3.42	–3.57	–4.25	–3.83	–5.57
Mean	–3.06	–3.79	–4.78	–5.63	–6.00

If instead of an integral controller a proportional controller with a value of 0.2 is used (which is the equivalent to the debt stock control in a quarterly model if nominal growth is 5%) then the debt stock is significantly better controlled. Further improvements can be made if one uses a proportional and integral control, and the stronger the proportional control is reacting to the deviation of the deficit from base the better the debt stock is managed. In the last column of Table 7 about a third of the variablity of the debt stock is removed as compared with the no feedback rule used in Table 5. However, progress across rules is not uniform, as one can see from the table. As is common in control problems, a dual controller is more effective at stabilising both the deficit and the debt stock. Even then, uncertainty can only be reduced but not removed.

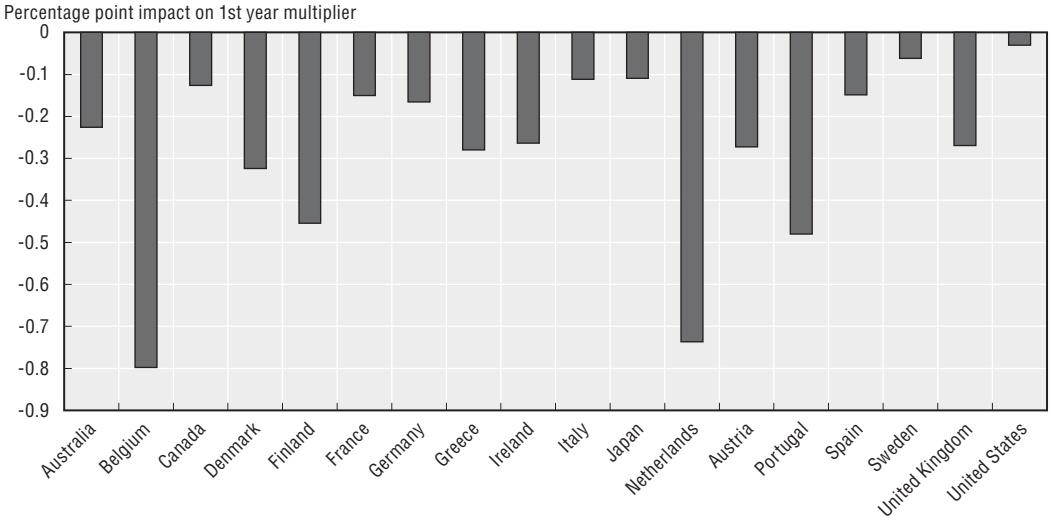
6. Unilateral *versus* synchronised fiscal innovations

When many countries are tightening policy simultaneously, the negative impact of domestic policy on output will be exacerbated by negative trade spillovers from policies

abroad. This is partially offset, especially in the smaller economies in the euro area, by the bigger impact of the joint action on ECB interest rate setting and more significant depreciation of the exchange rate. In order to assess the impact of synchronised policy innovations, we re-run the permanent spending shocks, which are reported in Table 4 above on a unilateral basis, applying a 1% of GDP spending-based consolidation in all 18 countries simultaneously.

Figure 15 illustrates the difference in the first year impact multiplier in each country in the joint consolidation scenario compared with the unilateral scenarios. Negative spillovers worsen the impact on output in all countries, with the biggest effects in the more open economies such as Belgium and the Netherlands. If the magnitude of policy innovations were to differ across countries, instead of the uniform 1% of GDP tightening illustrated in this scenario, joint consolidation could actually have a positive effect on output in some countries, reflecting the sensitivity of net trade to the exchange rate and relative price movements as well as the short-term sensitivity of demand to the real interest rate. The latter is particularly important in the United States and Japan, where spillovers from policy measures in the rest of the world are shown to be relatively limited.

Figure 15. **Impact of joint policy action relative to unilateral action**



Note: The figure shows the percentage point difference in the first-year multiplier in the simultaneous scenario and the unilateral scenarios from Table 4.

7. Fiscal consolidation and government borrowing premia

A number of studies have looked at the links between the risk premium on government borrowing (generally measured within the euro area as the spread of 10-year government bond yields over those in Germany) and fiscal sustainability, captured by current or expected values of the general government deficit or the stock of government debt. Table 8 reports key results from a sample of these studies. These studies suggest that rising government debt is likely eventually to put upward pressure on interest rates, so that fiscal tightening is likely to be necessary at some point. While the severe tightening of fiscal policy across the euro area has clearly made a significant contribution to the downturn, these studies generally suggest that improvements in the fiscal position are linked to a decline in government borrowing premia and therefore improve the medium-term sustainability of public finances and partly offset the contractionary effects of the consolidation.

Table 8. **Empirical relationship between government borrowing premia and fiscal variables**

	Spread (t – 1)	Debt to GDP ratio	Fiscal balance to GDP ratio	
				Implied long-run
Arghyrou and Kontonikas (2011)	0.74		–2.0 (t + 1)	–7.7
Attinasi et al. (2009)	0.97		–1.6 (t + 1)	–54.9
Bernoth and Erdogan (2012)		2.2	–16 (t + 1)	
De Grauwe and Ji (2012)		$-6.12\ (t) + 0.08\ (t)^2$		
Schuknect et al. (2010)		1.25	–12.64	

Note: Spread is defined as the 10-year government bond yield over that in Germany, expressed in basis points. (t + 1) indicates expectations 1 year ahead. $(t)^2$ indicates the current debt to GDP ratio squared.

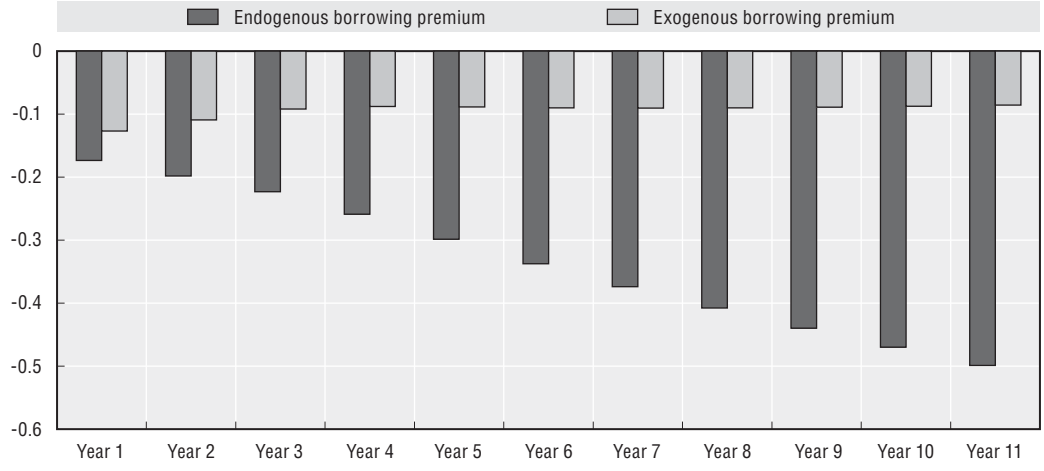
The empirical estimates, on average, point to a 2-4 basis point rise in interest rates for a 1% of GDP rise in the government debt to GDP ratio. This may overstate the impacts for non-euro area countries. IMF (2012) points out that, "fiscal indicators such as deficit and debt levels appear to be only weakly related to government bond yields for advanced economies with monetary independence".

In order to assess the impact of the potential feedback on borrowing premia, we model the government borrowing premium as:

$$GPREM = 0.04 * GDR$$

where *GPREM* is the government borrowing premium and *GDR* is the government debt to GDP ratio. Figure 16 illustrates the expected impact of a 1% of GDP fiscal consolidation programme on long-term interest rates, with and without allowing for the feedback from the decline in government debt on the borrowing premium in the United Kingdom. Similar results can be obtained for other countries. The impacts increase over time as the debt position improves. The impacts on GDP in the short term are negligible, although over time they become more significant. Where there is little scope for downward adjustment in interest rates, this channel can be expected to be impaired. However, where significant risk premia are present within the euro area (Greece, Ireland, Portugal, Spain, Italy) there is certainly scope for a decline in borrowing costs.

Figure 16. **Impact of 1% of GDP fiscal consolidation in the United Kingdom on long-term interest rates**



8. Conclusion

Fiscal multipliers differ across countries because the structure and behaviour of economies differ. They also differ within countries, depending on factors such as the fiscal instrument implemented, the policy response to fiscal innovations, and expectation formation by economic agents. In general in most countries fiscal policy multipliers are small, but are negative when fiscal policy is tightened. Spending multipliers tend be larger in the short term than tax multipliers, although in the real world it may be difficult to implement real cuts in the provision of government services quickly. More open and financially liberalised economies tend to have smaller multipliers. Expectation formation also matters. The more forward-looking are economic agents, the smaller the estimated multiplier. Tighter fiscal policy reduces growth in the short run in almost all circumstances, but a lower debt stock reduces pressures on real interest rates and hence in the longer term can raise sustainable output. This effect is larger for larger countries. As suggested by Delong and Summers (2012), in the current economic environment, multipliers may be larger than usual, due to heightened liquidity constraints related to problems in the banking sector and a weak economy. Limited downward flexibility in short-term interest rates also raise the expected effects on output from fiscal consolidation programmes.

The need to reduce government debt stocks cannot be denied, but their evolution is very uncertain. The bounds around any consolidation programme can be reduced by setting up automatic feedbacks that raise taxes in response to overshoots on targets for debts and deficits, but the uncertainty bounds cannot be reduced to zero. In general targeting the debt stock and the deficit is more effective than targeting either alone, as both are subject to shocks that make them deviate from target.

Notes

1. For a full description of NiGEM, see *http://nimodel.niesr.ac.uk*. A brief overview is provided in the Appendix.
2. Government investment and corporate tax receipts are generally a small proportion of the economy, and a 1% of GDP change to either would be a large proportionate change. In a temporary shock, the impact of a shift in government investment would be the same as a government consumption shock of the same magnitude. A long-run shock to either government investment or the corporate tax rate would change the real equilibrium of the economy.
3. This model describes myopic consumers. The approach to modelling forward-looking consumers is discussed in the Appendix.
4. The impact of the consolidation on risk premia is not taken into account. These are largely absent currently for large countries such as the United States, the United Kingdom, France and Germany. For small countries such as Greece, Ireland and Portugal this is important.
5. The parameters of consumption functions underlying NiGEM differ somewhat from those reported by Barrell and Davis (2007), due to different vintages and sample periods of data used in estimation.
6. The parameters of the rules are nested, and hence the differences are due to their innate properties.

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APPENDIX

The NiGEM model

The National Institute's global econometric model (NiGEM) can be used in a number of ways, from a backward-looking structural model to a version that has similar long-run properties as the dynamic stochastic general equilibrium models used by institutions such as the Bank of England.[1] Although the model is estimated it has a strong role for expectations, and it is also flexible, as it can be run under different models of expectations formation, depending upon the thought experiment being undertaken. Financial markets normally follow arbitrage conditions and they are forward looking. The exchange rate, the long-term interest rate and the equity price will all jump in response to news about future events. Fiscal policy making involves gradually adjusting direct taxes to maintain the deficit on target, but it is assumed that taxes have no direct effect on labour supply decisions. Monetary policy making involves targeting inflation with an integral control from the price level, as discussed in Barrell, Hall and Hurst (2006) and inflation settles at its target in all simulations. Some of the key features of the model that determine the outturns of the simulation studies are detailed further below.

Production and investment

GDP (Y) is determined in the long run by supply factors, and the economy is open and has perfect capital mobility. The production function has a constant elasticity of substitution between factor inputs, where output depends on capital (*K*) and on labour services (*L*), which is a combination of the number of persons in work and the average hours of those persons. Technical progress (*tech*) is assumed to be labour augmenting and independent of the policy innovations considered here. Fiscal tightening measures have a negative impact on GDP in the short run, but unless they permanently shift the desired level of capital, labour supply or technical progress, these effects dissipate over time and will not affect the level of output over the longer term.

$$Y = \gamma(\delta(K)^{-\rho} + (1-\delta)(Le^{\lambda_L tech})^{-\rho})^{-1/\rho} \quad (1)$$

Equation (1) constitutes the theoretical background for the specifications of the factor demand equations. Demand for capital is determined by profit maximisation of firms, implying that the long-run capital output ratio depends on the real user cost of capital. In general, forward-looking behaviour in production is assumed, and so investment depends on expected trend output four years ahead and the forward-looking user cost of capital. However, the capital stock does not adjust instantly, as there are costs involved in doing so that are represented by estimated speeds of adjustment. The user cost of capital is influenced by corporate taxes, depreciation and risk premia and is a weighted average of the cost of

equity finance and the margin adjusted long real rate. Fiscal innovations through the corporate tax rate or through government investment can permanently shift the level of the capital stock, and through this shift the long-run level of potential output.

Labour market and wage setting

Demand for labour is also determined by profit maximisation of firms, implying that the long-run labour-output ratio depends on real wage costs and technical progress. Labour supply is modelled as essentially exogenous, determined by demographics and an exogenous rate of participation.

The equilibrium level of unemployment is the outcome of a bargaining process in the labour market, as discussed in Barrell and Dury (2003). NiGEM assumes that employers have a right to manage, and hence the bargain in the labour market is over the real wage. Real wages, therefore, depend on the level of trend labour productivity as well as the rate of unemployment. The dynamics of the labour market depend on the estimated speed of adjustments in the wage and labour demand equations, and the extent to which short-term wage dynamics depend on (rational) expectations of future inflation and on current or past inflation. The degree of price inertia/real wage flexibility in the economy is an important factor underlying the different dynamic profiles observed in response to a fiscal innovation.

Consumer behaviour

As Barrell and Davis (2007) show, both the level of total asset based wealth [ln(*TAW*) or ln(*NW* + *HW*)] and changes in financial [(*d*ln(*NW*)] and especially housing wealth [*d*ln(*HW*)] will affect consumption (*C*).[2] Their estimates suggest that the impact of changes in housing wealth have five times the impact of changes in financial wealth in the short run, although long-run effects are the same. Barrell and Davis (2007) also show that adjustment to the long-run equilibrium shows some inertia as well.[3] Al Eyd and Barrell (2005) discuss borrowing constraints, and investigate the role of changes in the number of borrowing constrained households. It is common to associate the severity of borrowing constraints with the coefficient on changes in current real incomes [*d*ln(*RPDI*)] in the equilibrium correction equation for consumption (parameter b_1). These coefficients are important in evaluating impact multipliers. They may also be time-varying and dependent on the state of the economy, as the number of liquidity constrained consumers will rise during an economic downturn. This may be a key channel through which fiscal multipliers become dependent on the state of the economy, as suggested by *e.g.* Delong and Summers (2012). One can write the equation for *d*ln(*C*) as:

$$\begin{aligned} d\ln(C_t) = \lambda\{\ln(C_{t-1}) - [a + b_0 \ln(TAW_{t-1}) + (1 - b_0)\ln(RPDI_{t-1})]\} \\ + b_1 d\ln(RPDI_t) + b_2 d\ln(NW_t) + b_3 d\ln(HW_t) \end{aligned} \quad (2)$$

where the long-run relationship between ln(*C*) and ln(*RPDI*) and ln(*TAW*) determine the equilibrium savings rate, and this relationship forms the long-run attractor in an equilibrium correction relationship. The logarithmic approximation is explained in Barrell and Davis (2007).

Operating in forward-looking consumption mode, consumers react to the present discounted value of their expected future income streams, which is approximated by total wealth (*TW*), although borrowing constraints may limit their consumption to their personal disposable income in the short run. Total human wealth is defined as:

$$TW_t = Y_t - T_t + TW_{t+1} / [(1 + rr_t)(1 + my_t)] \quad (3)$$

Y is real income, T are real taxes, and the subscript $t + 1$ indicates an expected variable which is discounted by the real interest rate rr_t and by the myopia premium of consumers, my_t. The equation represents an infinite forward recursion, and permanent income is the sustainable flow from this stock. Fiscal multipliers are sensitive to the expectations formation of households. Fully forward-looking consumers anticipate that current consolidation measures may entail lower tax rates in the medium to longer term, offsetting some of the negative impact on consumption in the short term, as households aim to smooth their consumption path. Multipliers are higher with myopic consumers.

Government sector

In order to evaluate multipliers a reasonably disaggregated description of both spending and tax receipts is needed. Corporate (*CTAX*) and personal (*TAX*) direct taxes and indirect taxes (*MTAX*) on spending are modelled, along with government spending on investment (*GI*) and on current consumption (*GC*), and transfers (*TRAN*) and government interest payments (*GIP*) are separately identified. Each source of taxes has an equation applying a tax rate to a tax base (profits, personal incomes or consumption). As a default, government spending on investment and consumption are rising in line with trend output in the long run, with delayed adjustment to changes in the trend. They are re-valued in line with the consumers' expenditure deflator (*CED*). Government interest payments are driven by a perpetual inventory of accumulated debts. Transfers to individuals are composed of three elements, with those for the inactive of working age and the retired depending upon observed replacement rates. Spending less receipts gives the budget deficit (*BUD*), which adds to the debt stock.

$$BUD = CED^{*}(GC + GI) + TRAN + GIP - TAX - CTAX - MTAX \quad (4)$$

It has to be considered how the government deficit (*BUD*) is financed. Either money (*M*) or bond financing (*DEBT*) are allowed:

$$BUD = d(M) + d(DEBT) \quad (5)$$

and rearranging gives:

$$DEBT = DEBT_{t-1} + BUD - d(M) \quad (6)$$

In all policy analyses a tax rule is used to ensure that governments remain solvent in the long run. The default rule is applied to the personal direct tax rate, which is adjusted endogenously to bring the government deficit into line with a specified target. This ensures that the deficit and debt stock return to sustainable levels after a shock. A debt stock target can also be implemented and this is discussed below. The income tax rate (*TAXR*) equation is of the form:

$$TAXR = f(\textit{target debt or deficit ratio} - \textit{actual debt or deficit ratio}) \quad (7)$$

If the government budget deficit is above the target (*e.g.* 3% of GDP and the target is 1%), then the income tax rate is increased.

Monetary policy

A tighter fiscal policy will allow short-term interest rates to be lower now and in the future if there is no change to the monetary policy target, and hence long-term interest rates will be lower now. Barrell (2001) reviews evidence on expansionary fiscal contractions, and concludes they are exceptionally rare. Interest rates are set by the monetary authority in relation to a targeting regime, where policy interest rates are set in relation to a rule that is normally forward

looking. Fiscal multipliers depend on the assumed targeting regime, and the extent to which fiscal innovations are accommodated by monetary policy in the short term. We distinguish two types of rules, those that target only inflation and those that target the price level or a nominal variable such as GDP or the money stock. During the "Great Moderation" era, central bankers and many economists became convinced that they had changed the world they lived in by adopting simple feedback rules for monetary policy in combination with rules for fiscal policy that kept debt in bounds. The simple feedback rule was based on the Taylor Rule (TR) that suggests that when inflation increases, the central bank should increase the interest rate more than in proportion to the rise in inflation, and hence the real interest rate would rise and help choke off demand. In a forward-looking world it is possible to improve on this principal. If agents see the central bank as fully credible, then the announcement of a price level target (PLT), rather than just an inflation target, will stabilise fluctuations in output and in inflation. A price level targeting central bank will loosen policy more rapidly as it has to get the price level back to target. The converse will be true in a boom. These two feedback rules are shown in equation (8) below, with *int* being the intervention rate, *ssr* being the steady state (endogenous) real interest rate, *og* being the output gap, *inf* and *infl* being the inflation rate and the target, and *P* and *PT* being the price level and the price level target.

$$int_t = a_0 + a_1 ssr_t + a_2 og_t + a_3(inf_{t+1} - infl) + a_4(P_t - PT_t) \quad (8)$$

In a Taylor Rule, a_0 is zero, a_1 is 1.0, a_2 is 0.5, a_3 is 1.5 and a_4 is zero, whilst in a PLT regime a_1 is zero, a_2 is also zero, and a_3 is set to 0.7 and a_4 to 0.4. The PLT rule has the advantage of working only on observables. The same is true of a two pillar strategy as embraced by the ECB. The bank responds to deviations of inflation from target and also deviations of a nominal aggregate (*NOM*) – the money stock for instance – as described in the equation:

$$int_t = b_0 + b_1(inf_{t+1} - infl) + b_2(NOM_t - NOMT_t) \quad (9)$$

Forward looking financial markets

A deflationary shock such as a fiscal tightening will have a weaker interest rate response under a Taylor Rule than under price level targeting, and both may be weaker than a two pillar rule. If actors know the rule is in place then they will form expectations of the future path of short rates, and this will cause the current long rate to change, along with the exchange rate and the equity price. If fiscal policy is expected to be tightened in the future then long rates will fall now, increasing the offset, and perhaps even inducing a short-term expansion of output. Forward-looking long rates (*LR*) should be related to expected future short-term rates:

$$(1 + LR_t) = \prod_{j=1}^{T} (1 + int_{t+j})^{1/T} \quad (10)$$

Forward-looking equity prices (*EQP*) are related to future profits (*PR*) in a forward recursion where *eprem* is the equity premium:

$$EQP_t = PR_t + \frac{EQP_{t+1}}{(1 + int_t)(1 + eprem_t)} \quad (11)$$

The exchange rate depends on the expected future path of interest rates and the exchange rate risk premia, solving an uncovered interest parity condition, so that the expected change in the exchange rate is given by the difference in the interest earned on assets held in local and foreign currencies:

$$e_t = e_{t+1}\left(\frac{1 + \text{int}^*_t}{1 + \text{int}_t}\right)(1 + rp_t) \quad (12)$$

where e_t is the bilateral exchange rate at time t (defined as domestic currency per unit of foreign currency), int_t is the short-term nominal interest rate at home set in line with a policy rule, int_t^* is the interest rate abroad and rp_t is the exchange rate risk premium.

Notes

1. The Bank of England Quarterly model is discussed in Harrison *et al.* (2005). NiGEM is discussed in Barrell, Holland and Hurst (2007), Barrell, Hurst and Mitchell (2007) and in other papers at *www.niesr.ac.uk*. NiGEM does not impose maximising equilibrium conditions in the same way as Dynamic Stochastic General Equilibrium models, but has the same steady-state equilibrium properties.
2. Throughout *d* is the change operator and *ln* is the natural logarithm.
3. While the approach underlying NiGEM consumption equations is the same used in Barrell and Davis (2007), the estimated parameters differ, due to different vintages and sample periods of data used in estimation.